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Disconnected dots?: A systematic review of governance challenges for natural resource management

Abstract

As concerns for the ongoing and increasing degradation of the natural environment worldwide, have increased the impetus for action, and development of governance arrangements to support natural resource management. Despite this, issues around governance remain a significant challenge to the success of natural resource management. This study reports the findings of a systematic literature review of 240 papers to better understand how governance challenges manifest spatially, how they change over time, and identify key priority areas for strategic governance reform. This paper reveals that the capacity of natural resource management governance systems internationally is most limited by factors that limit connectivity and collaboration between stakeholders in decision-making processes, and the alignment of vision and objectives across institutions. The paper shows clear spatial disparities and temporal changes in the number of studies and governance challenges of natural resource management identified in developing and developed countries.

Keywords: *natural resource management, governance, environmental governance, environmental outcomes, governance challenges, environmental management*

1.0 Introduction

In recent decades, governance has increasingly been identified by scholars and practitioners as a lynchpin in the success of natural resource management. Indeed, recognising the widespread failures of historic 'top-down', technocratic and generally government-led management practices, in the last two decades many management groups and governments have adopted more participatory, collaborative, and polycentric governance arrangements (Bixler, 2014; Marcus & Onjala, 2008; Njaya, 2007; Robins, 2008; Yeboah-Assiamah et al., 2017). This radical shift in governance paradigms has involved significant experimentation with novel approaches to decision-making, with varying levels of success and influence on outcomes in social-ecological systems (Ison et al., 2015; McFadgen & Huitema, 2017; Mitchell et al., 2014). This shift in paradigm also spurred significant discussion surrounding what exactly constitutes best practice or 'good governance' for natural resource management. Empirical studies reveal that the reality of achieving such principles in practice, however, remains a significant challenge to the success of natural resource management planning and implementation activities (Dale et al., 2016; Kuzdas et al., 2015; Petursson & Vedeld, 2017; Waylen et al., 2018). Where environmental degradation continues, despite significant investment internationally in novel approaches to achieving environmental objectives and on-ground actions, improving governance system functionality is critical to maintaining and protecting the future of natural resources.

A plethora of governance challenges limits the capacity of natural resource management governance systems to deliver their desired environmental, social, and economic

outcomes across scales and increase the risk of governance system failure. In some cases, there may only be a limited number of challenges limiting the capacity of governance systems, more frequently, however, there are numerous interconnected governance challenges preventing the governance system from succeeding in delivering its desired outcomes. Governance challenges may include conflict between stakeholders (Schafer, 2016), lack of resources to undertake certain strategies (Scheba, 2017), absence of political support for specific environmental strategies (Hill, 2013), or a lack of inclusion or availability of indigenous knowledge for understanding natural systems (Chief et al., 2016). While there has been a substantial focus on identifying and addressing these governance challenges in recent decades, worldwide environmental degradation has continued worldwide (O'Neill, 2017). This suggests that internationally, natural resource governance systems are failing to adequately respond to environmental degradation and governance challenges, limiting action to address such degradation.

There are a number of studies that identify and examine governance challenges in specific natural resource management case studies. Such studies are somewhat piecemeal in their focus on governance challenges in the context of a specific site, governance system, or geographic area. While they are helpful in understanding the strengths and weaknesses of individual case study governance systems, they are unable to provide insight into governance challenges across multiple governance systems, or trends in natural resource management governance challenges internationally. This study argues that the broader spatial and temporal trends in governance challenges for natural resource management systems require further examination. This paper explores natural resource management governance challenges in the literature. Using a systematic quantitative literature review methodology this study identifies key issues, knowledge gaps, whether governance challenges are spatially influenced, and how they have evolved over time. The focus questions of this research are: Are natural resource management governance challenges geographically defined? And; how have governance challenges in natural resources management evolved over time? Understanding the answers to these questions provides practitioners and researchers with greater clarity surrounding where greater support and investment of time, energy and other resources are most needed to improve governance system functionality.

2.0 Governance and Natural Resource Management

Governance systems are defined as the networks of formal and informal processes, interactions and arrangements through which decisions are made and outcomes delivered (Davidson et al., 2006; Young, 1997). Governance can be seen as the means by which social coordination occurs through one or multiple interactions, including self-regulation, deliberation, authoritative choice and negotiation (Bodin, 2017; Kemp & Parto, 2005). Reflecting this, governance systems consist of broad and interrelated social, environmental and economic silos that coexist and interact across scales and thus cannot and should not be considered in isolation. Practice has shown us that these silos are highly interconnected, demonstrating for example that environmental degradation may be underpinned by social dysfunction or economic deficiencies (Dietz et al., 2009; Fairhead & Leach, 1995; Mycoo et al., 2017; Rapport et al., 1998). Similarly, economic prosperity may result in environmental degradation and social disengagement (Ghazoul et al., 2010; Tamazian et al., 2009). Despite the widespread recognition of the interconnectivity of these silos, governance research and analysis often focuses on silos of management in isolation from each other (Failing et al., 2007; Raymond et al., 2010).

Within the broader silo context there are a number of focus areas for policy and action, including social or economic development, education, health, industry, or environmental management. These focus areas involve specific groups of stakeholders or communities of interest and tend to draw on a specific skill- and knowledge-set within that community. They can occur across multiple spatial, temporal and political scales. The importance of understanding the multiple scales at which governance plays out have been widely emphasised in the governance and planning literature (Cash et al., 2006; Cash & Moser, 2000; Ostrom, 2012). The different spatial and temporal scales are complex and interdependent. Governance systems playing out at one spatial scale are capable and in fact likely to influence other governance sub-systems.

Managing natural resources can be challenging because ecological and social systems involve a high degree of nonlinearity, uncertainty, interconnectivity, emergence, and conflict (Brugnach et al., 2011). The governance systems responsible for managing natural resource management issues are themselves also characterised as complex due to their devolved structure, high diversity of stakeholders and interests included in decision-making, and their interdependency across multiple governance silos (Failing et al., 2007; **Holley**, 2014; Raymond et al., 2010).. In addition to diverse perspectives, there are also disparities in the spread of resources, power and level of organisation among stakeholders (Bouwen & Taillieu, 2004). Power relations between stakeholders can be particularly influential on the success of natural resource management governance arrangements (Armitage, 2005). There is strong support in the literature that 'successful environmental management is the product of the collective, bottom-up action of interregional actors, nested within government hierarchies' (T. Morrison, 2007, p. 230). However, such a governance system remains challenging to develop and maintain in practice (Adams et al., 2017; Kabote & John, 2017), inhibiting the ability of such governance systems to deliver improved environmental conditions.

3.0 Methodology

This research applied a systematic quantitative literature review methodology. Systematic quantitative literature review methodologies use bibliometric and content analysis of articles that meet a certain set of inclusion criteria and are drawn from academic databases and search engines as a means of identifying gaps in the literature and analysing trends in the literature (Pullin & Stewart, 2006). The methodology has been widely applied in the health and medical disciplines (Mulrow, 1994), and more recently has become increasingly common in the environmental studies literature (Juerges & Hansjürgens, 2018; Vink et al., 2013). It is seen as a particularly strong and unbiased methodology for identifying trends in the literature due to its use of a rigorous *a priori* protocol and use of predefined criteria (Pullin & Stewart, 2006). A range of databases of academic journal papers can be utilised to collect data for inclusion in a systematic quantitative literature review, including Scopus, Web of Science, and Google Scholar. Google Scholar was selected for use in this study due to its wider coverage of journal papers in the social and political sciences that are not as comprehensively indexed in the other two databases (Moed et al., 2016).

The Governance Systems Analysis framework developed by Dale et al. (2013a) and was used to structure the search protocol, data analysis and explore the governance challenges in natural resource management governance systems internationally. The

framework has previously been applied to examine governance in a range of different natural resource management case studies, such as the Great Barrier Reef (Dale et al., 2013b), and Cape York Peninsula. Based on structural-functionalism, the Governance Systems Analysis framework examines the structural and functional elements of governance systems (Dale et al., 2013a).

A non-time limited Google Scholar search for English-language papers dating up to the end of 2018 using Boolean search terms 'natural resource management' AND 'governance challenges' resulted in 2900 hits. These key search terms were selected to focus on governance in natural resource management systems, without introducing bias surrounding the kinds of governance challenges explored (e.g. availability of resources or relationships between key stakeholders). To be included in this review, papers had to meet four explicit criteria:

1. Focus on a case study of natural resource management
2. Identify at least one factor inhibiting governance ('governance challenges') and the governance system's capacity to deliver desired environmental outcomes. This included studies that identified governance challenges as being either wholly, or partially responsible for limiting the ability of the governance system to achieve its desired environmental outcomes.)
3. Describe the point in the planning process that the governance challenges were occurring.
4. The governance challenges had to occur largely within (rather than external to) the governance system of reference.

The initial categories of governance challenges were drawn from those identified by Dale et al. (2013a), and additional new categories were then included based on the analysis of articles. The categories drawn from Dale et al (2013a) included challenges relating to the governance system's decision-making capacity, connectivity between key stakeholders, and the availability/application of different knowledge types in decision-making (Dale et al., 2013a). The results were then further refined with the exclusion of conference papers, books, book reviews, policy papers, and reports, as well as the removal of technical scientific studies. This set of criteria resulted in a total of 240 articles. The content of the papers was then analysed manually and then coded based on a number of criteria, including

- bibliographical data (date of publication, location of the research, journal),
- the location and focus of case studies used in each paper,
- methodologies used to explore governance challenges,
- stage of the planning process the governance challenges were identified to occur in (vision/objective setting, research, strategy development, implementation, and/or monitoring), and;
- governance challenges identified.

The coded data was compiled in an excel database for analysis. Governance challenge categories were tested and revised iteratively throughout the analysis to reflect similarities and differences in categories.

4.0 Overview of studies and trends

Using the above methods, a total of 240 papers, from 114 academic journals were identified as meeting the inclusion criteria. The most common journals for publication

were *Ecology and Society (12%), Society and Natural Resources (11%),* and *Marine Policy (11%)*. All of the articles included in this research were published in interdisciplinary journals, with varying emphasises on topics such as environmental economics, landscape planning, climate change, marine and water resources, and environmental law. The number of publications and diverse list of journals they are published in demonstrates the wide breadth of interest in natural resource management governance issues.

The frequency of publications discussing the governance challenges of natural resource management has increased steadily since 2003, with a particularly strong surge between 2013 and 2016 (Figure 1). This surge corresponds to international events that drew attention to environmental issues and their governance systems, including the Rio+20 Summit in 2012, and COP16 in 2010 (Howes et al., 2017). The number of publications dropped slightly in 2017, before trending upwards again in 2018.

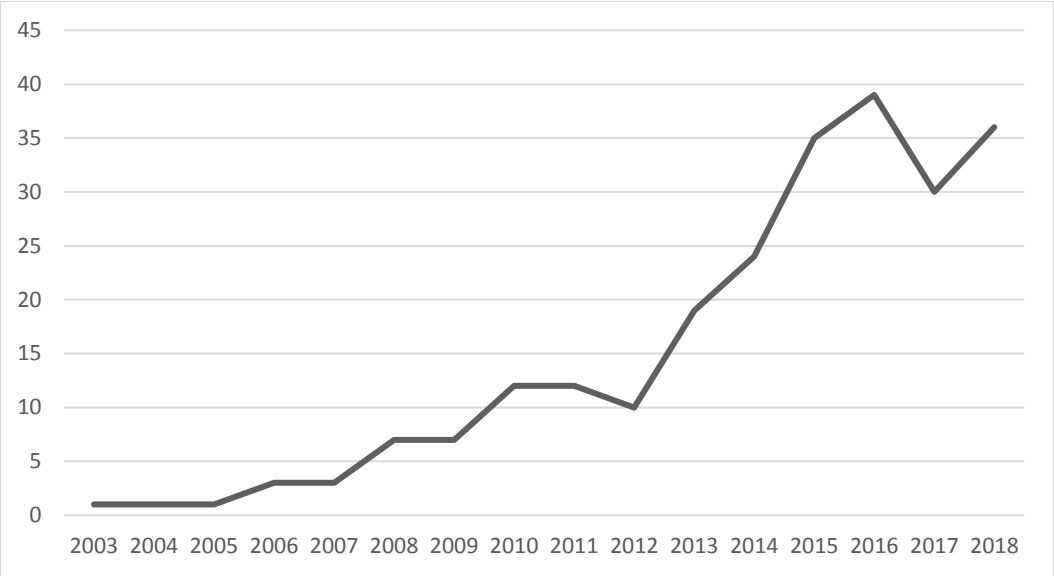

Figure 1: Number of journal papers published on 'natural resource management' and 'governance challenges between 2003 and 2018

4.1 Geographic distribution trends in natural resource management governance research

The geographic distribution and frequency of governance challenges is highly varied relative to the spatial, political and cultural characteristics of planning systems internationally. Reflecting this plurality, the literature has largely focussed on comparing natural resource management and governance challenges in natural resource management regimes across multiple countries (22%), with fewer studies from North America (19%), Australia (17%), Africa (16%), and Asia (14%) (Figure 2). Research examining case studies in Europe (6%), and South America (6%) was also limited. In the 15-year period this study drew papers from, there was a significant shift in the geographical origins of research exploring governance challenges in natural resource management. In 2003-2007 studies from Australian authors made up 44% of all papers (4 of 9 papers), by 2013-2018 this had dropped to 15% (28 of 185 papers). Congruently, North America was the source of only 11% (1 of 9 papers) in 2003-2007 and had doubled as the origin of 20% of all papers published on the topic in 2013-2018 (37 of 185 papers). Over the same 15-year period, case study locations varied somewhat, with increases in

the number of case studies located in the North and South Americas (9% increases), and declines in Asia (9% decline), Europe (7% decline), Australia (7% decline), and Africa (6% decline). The number of papers examining multiple countries remained stable, with little change between 2003-2018.

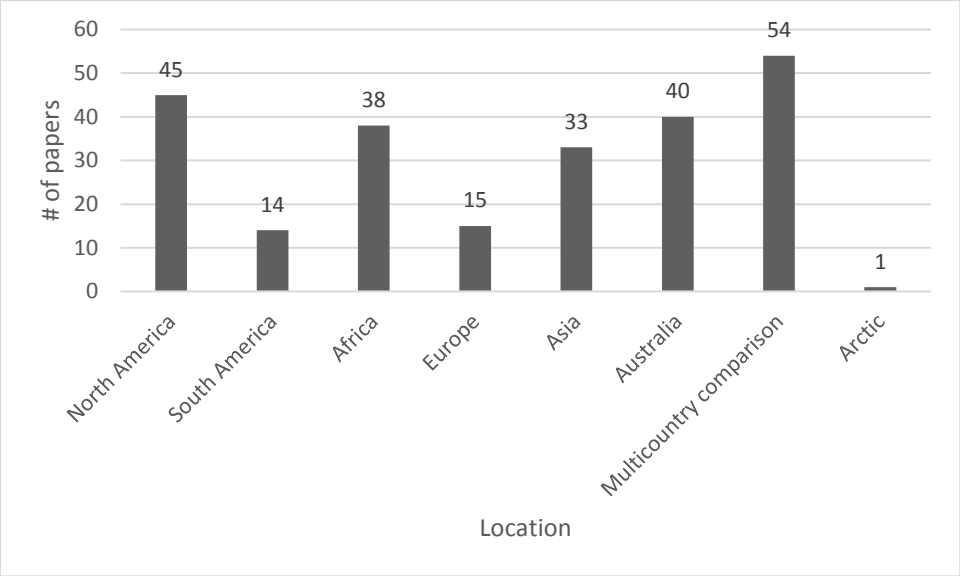

Figure 2: Spatial distribution of case study locations

Governance challenges were discussed in the research in the context of a wide variety of natural resources. Water bodies and rivers (24%) were the most commonly discussed case studies, with slightly fewer studies looking at governance challenges in forestry (18%), marine or coastal areas (13%), or natural resources generally (10%) (Figure 3). A lower number of studies were focussed on areas with more defined boundaries or resource types such as fisheries (7%), national parks (5%), and catchments (5%). There was also a dearth of studies looking at governance challenges surrounding agriculture (3%), managing pests and weeds (1%), and extractive resources (2%). While the majority of these remained fairly similar in their percentage of total publications between 2003 and 2018, some shifts were evident (Table 1). For example, research examining governance challenges fisheries reduced significantly from 22% in 2003-2007 to 6% in 2013-2018. Forestry increased moderately from 11% in 2003-2007 to 22% in 2013-2018 (Table 1). The prevalence of studies examining governance challenges in managing national parks has declined since 2003 by 6%.

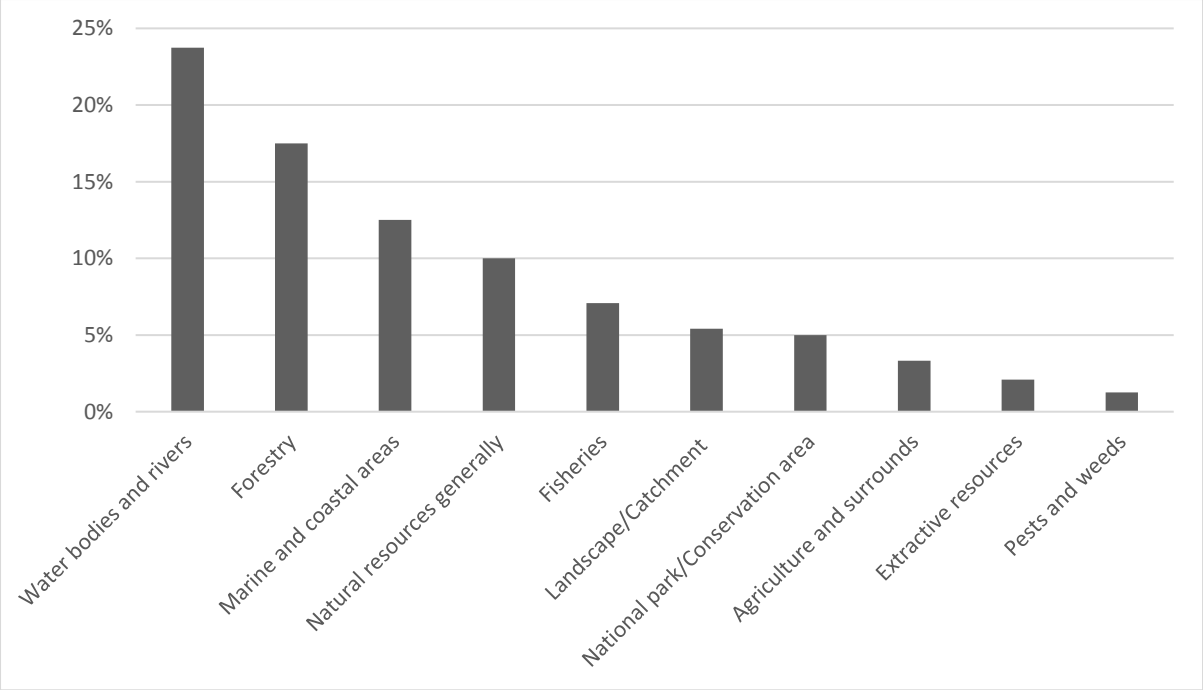

Figure 3: Natural resources examined in case study research

Table 1: Natural resources examined in articles 2003-2018

	2003-2007	2008-2012	2013-2018
Landscape/Catchment	11%	2%	9%
Marine/Coastal area	11%	15%	13%
Fisheries	22%	15%	6%
Forestry	11%	15%	22%
National park/conservation area	11%	8%	5%
Natural resources generally	11%	15%	14%
Water bodies and rivers	22%	25%	25%
Extractive resources	0%	4%	2%
Agriculture	0%	2%	4%

The natural resource management systems in which governance challenges were studied in the research also varied spatially (Table 2). Of note, case studies in Australia were found to more frequently discuss governance challenges in broader interconnected systems of decision-making (35%), rather than those pertaining to a specific resource type. The majority of European case studies explored governance challenges surrounding the management of water bodies and rivers (40%). However, European case studies also constituted the greatest percentage of papers across continents exploring governance issues relating to the planning and management of natural resources in national parks and conservation areas (27%). Table 2 and the above suggest that governance challenges are likely geographically defined, not only as a result of their physical location, but also the political and cultural values associated with certain natural assets in decision-making and political processes.

Table 2: Spatial distribution of natural resources discussed in articles

	Asia	Multi-country comparison	Europe	Africa	North America	South America	Australia
Landscape/ catchment	3%	12%	0%	13%	4%	6%	12%
Marine/coastal area	10%	12%	13%	3%	9%	31%	19%
Fisheries	0%	15%	13%	13%	9%	13%	2%
Forestry	42%	29%	0%	26%	20%	25%	0%
National park/ conservation area	0%	5%	27%	8%	9%	6%	0%
Natural resources generally	0%	7%	7%	10%	4%	0%	35%
Water bodies and rivers	29%	24%	40%	18%	30%	13%	26%
Extractive resources	3%	2%	0%	8%	2%	0%	0%
Agricultural land uses	6%	5%	0%	3%	7%	0%	2%
Specific species/habita t type	6%	5%	0%	0%	7%	0%	5%

4.2 Governance challenges in the research

The governance challenges discussed in the literature can be broadly separated into five categories, based on the step of the planning and management process that they occur within (Dale et al., 2013b). Approximately 39% of all of the publications examined in this study raised implementation as the policy phase in which governance challenges were inhibiting their success. Significantly fewer identified governance challenges as occurring in the vision and objective setting phase (19%) or the strategy development phase (31%). Monitoring and evaluation (6%) and research and analysis (6%) were the least likely steps for governance challenges to be identified as inhibiting the capacity of governance systems to manage natural resources.

The publications reviewed in this study described a multitude of governance challenges that inhibit the ability of governance systems to manage natural resources effectively and deliver their desired management outcomes (Table 3). As shown in Table 3, the three most commonly identified governance challenges were all related to connectivity within governance systems. They include a lack of *alignment of vision and objectives across institutions (79%), connectivity of stakeholders* to decision-making (65%), and inadequate or missing collaborative policy-making frameworks (60%). On the other hand, very few papers identified or explored governance challenges surrounding knowledge, particularly limitations in the use of indigenous knowledge (5%), the availability of decision-support tools (5%), and knowledge retention over time (4%).

Table 3: Governance challenges inhibiting capacity to manage natural resources

Governance Challenges		# of papers	% of papers
	Setting higher level targets	41	17%
	Availability of resources	113	**47%**
	Research and analysis capacities	13	5%

Capacity	*Setting clear targets*	116	48%
	Capacity to implement	106	44%
	Corporate governance	16	7%
	Monitoring capacity	25	10%
	Leadership capacity	25	10%
Connectivity	*Connectivity of stakeholders to decision-making*	156	65%
	Alignment of vision and objectives across institutions	190	79%
	Collaborative policy-making frameworks	144	60%
	Conflict resolution mechanisms	81	34%
	Linkages between research and practice	21	9%
	Vertical/horizontal alignment	95	40%
	Implementation partnerships	32	13%
	Connection between stages of the planning process	43	18%
Knowledge	*Availability of knowledge*	73	30%
	Use of indigenous knowledge	13	5%
	Knowledge retention over time	10	4%
	Availability/use of decision-support tools	12	5%

Table 4 shows that governance challenges have been unevenly studied, with a greater number of studies examining governance challenges in developed countries (49%) compared with developing countries (34%). Connectivity issues remain the most frequently identified type of governance challenge affecting natural resource management governance systems in developed, developing and multi-country comparative studies. This was followed by capacity and knowledge use related governance challenges.

Table 4: Comparison of governance challenges inhibiting capacity to manage natural resources in developed countries, developing countries, and multi-country comparison case studies

Governance Challenges		% of total case studies in developed countries	% of total case studies in developing countries	% of total case studies on multi-country comparisons
Capacity	*Setting higher level targets*	12%	8%	2%
	Availability of resources	28%	18%	10%
	Research and analysis capacities	5%	2%	0%
	Setting clear targets	28%	10%	5%
	Capacity to implement	26%	14%	7%
	Corporate governance	4%	3%	1%
	Monitoring capacity	7%	5%	2%
	Leadership capacity	2%	5%	2%
Connectivity	*Connectivity of stakeholders to decision-making*	33%	26%	14%
	Alignment of vision and objectives across institutions	40%	24%	13%
	Collaborative policy-making frameworks	25%	19%	10%
	Conflict resolution mechanisms	16%	11%	8%
	Linkages between research and practice	8%	3%	1%
	Vertical/horizontal alignment	23%	15%	8%
	Implementation partnerships	9%	5%	3%
	Connection between stages of the planning process	13%	5%	4%

Knowledge-use	*Availability of knowledge* *Use of indigenous knowledge* *Knowledge retention over time* *Availability/use of decision-support tools*	20% 2% 5% 3%	10% 1% 1% 1%	5% 2% 1% 1%
	Total % of papers studied	**49%**	**34%**	**18%**

5.0 Discussion

5.1 Governance challenges in the research

The findings of this research reinforce that governance challenges are an ever-present, and ubiquitous stumbling block for natural resource planners and managers. In exploring the nuances of governance challenges described in 240 international case studies, it became clear that strong interrelationships exist between governance challenges, and that often it is the sum of the total of interacting and interdependent challenges, rather than a single governance challenge affecting the overarching capacity of a natural resource management governance system delivering to deliver social, environmental and other desired outcomes. This is discussed further below.

5.1.1Capacity

Governance challenges related to decision-making capacity in eight broad categories represented 35% of the governance challenges identified across 240 papers. Across the eight categories, a lack of availability of relevant human, financial, infrastructure, and knowledge resources was cited by 113 (47%) publications as the primary factor inhibiting the capacity of institutions to deliver desired outcomes within natural resource governance systems. Many papers identified a lack of multiple resources as limiting decision-making capacity and emphasised the compounding impact of such restrictions can have in addressing environmental issues over time. For example, in a study of weed management in the Northern Territory of Australia, L. Head and Atchison (2015) identified a lack of human and financial resources as a factor lowering the capacity of land managers to simultaneously address immediate issues such as fire threat, and managing ongoing and emerging weed infestations.

The second most common capacity-related governance challenge was the inability to set clear targets (106 papers, 48%). Difficulty setting higher-level targets was also raised as a governance challenge limiting the capacity of institutions to deliver their desired outcomes in 41 papers (17%). Access to reliable and location-specific information was identified as a challenge to developing both clear and higher level management targets in case studies in Canada (Price et al., 2009), Sweden (Elmqvist et al., 2006), and Australia (Bell & Park, 2006). In a study of ecosystem-based management in Great Bear Rainforest in Canada, for example, planners were limited in their ability to set clear or long-term ecosystem management targets by a lack of regionally specific, multidisciplinary information, and incomplete ecosystem and focal species habitat inventories for the region (Price et al., 2009).

An inability to implement a broad mix of strategic solutions was identified in 106 papers, (44%). Factors limiting capacity to implement a broad mixture of strategic solutions variously included issues such as poverty (Bushley, 2010; Riggs et al., 2018), transboundary inconsistencies in management, regulations or political will (Daniel et al.,

2013; McConnell William & Sweeney Sean, 2005), and land ownership (Fleischman et al., 2010; Razzaque, 2017). A large number of the papers citing these issues recognised the interplay between limited human, infrastructure, knowledge, and financial resources and institutions' reduced capacity to implement a broad mixture of strategic solutions.

Challenges arising as a result of low levels of leadership capacity (10%), monitoring capacity (10%), inadequate corporate governance arrangements (7%), and research and analysis capacities (5%) were the least frequently cited governance challenges affecting decision-making capacity. The low representation of these governance challenges suggests that they may not be considered a significant threat to the overarching delivery of desired outcomes within the governance systems, but rather a threat to the efficacy of decision-making institutions seeking such outcomes. Moreover, some issues surround capacity, such as the capacity to monitor may be seen as problematic in a broad governance capacity sense, but considered less significant of a challenge to governance system functionality compared to issues surrounding availability of resources to undertake any form of planning, or implementation to address an environmental problem. It also indicates the above areas are poorly studied, and further examination may be necessary to better understand their role in limiting governance system decision-making capacity.

5.1.2. Connectivity

Governance challenges related to stakeholder connectivity in eight broad categories represented the majority (58%) of governance challenges identified across 240 papers. The most commonly identified governance challenge relating to connectivity was a lack of alignment of vision and objectives across institutions and was mentioned in 190 papers (79%). In some instances, these issues stemmed from differences in values or perspectives between institutions. For example, differences in perceptions regarding best management practices of elk have led to significant divisions between institutions involved in decision-making in the Greater Yellowstone Ecosystem in the United States of America (Clark & Vernon, 2017). The divisions between institutions were found to constrain the scope of policy deliberations, strategy development, and improvements to elk management practices (Clark & Vernon, 2017).

Low levels of connectivity of stakeholders to decision-making were identified as a governance challenge in 156 papers (65%). Case studies in Canada (Simms et al., 2016), Australia (Smith & Lawrence, 2018), Madagascar (McConnell William & Sweeney Sean, 2005), and Chile (Cárcamo & Gaymer, 2013) found poor stakeholder connectivity significantly impeded the success and effectiveness of planning and implementation activities. In a study of governance in Areka, Ethiopia in the Eastern African Highlands German et al. (2010) found, for example, that female farmers were largely excluded from contributing towards the formulation and enforcement of resource management by-laws as a result of technology dissemination efforts, which largely targeted wealthy male farmers.

Fragmented, or missing collaborative policy-making frameworks were identified as governance challenges in 144 papers (60%). Such fragmentation was cited to be the result of a wide variety of factors, such as the hybridisation of governance structures (T. H. Morrison, 2007), divergent stakeholder interests (Hovik et al., 2010), and boundary disparities (Sreeja et al., 2012). T. H. Morrison (2007) for example, reiterated the 'ever-

increasing array of government and non-government actors at multiple scales' as a major factor contributing to the complexity of natural resource management governance systems in Australia, and the degree to which they included collaborative policy-making frameworks. The findings of this research suggest that connectivity issues primarily occur during strategy development, as weak or missing implementation partnerships were identified as governance challenges in only 32 papers (13%). For example, Bullimore (2014) found weak collaborative partnerships, and a lack of incentives for relevant authorities to work collaboratively on conservation challenges in Carmarthen Bay, Wales (UK), limits the overarching capacity to implement the European Union's Habitats Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Inadequacies of vertical and/or horizontal alignment of governance structures were described in 95 papers (40%). Case studies in South Asia, Canada, and New Zealand indicate that alignment issues may be the result of the separation of natural resource management issues into poorly connected policy silos (Holley, 2014), weak relationships between key decision-making bodies (Dunn et al., 2015), and mismatches in institutional priorities or policy mandates across scales (Fidelman et al., 2012). In a study of coordination of activities to reduce and manage deforestation and degradation in seven countries, Korhonen-Kurki et al. (2016) found that there was a significant vertical disconnect between the different levels of government. The study found that the lack of vertical integration and coordination led to delayed implementation of strategies, and an exacerbation of existing capacity issues at the local scale (Korhonen-Kurki et al., 2016).

Issues surrounding unavailable or flawed conflict resolution mechanisms were found to be a key governance challenges in 81 out of 240 papers (34%). Hovik et al. (2010) identified cost as one contributing factor, limiting the availability of conflict resolution mechanisms in Norway and Sweden to provide Indigenous, government and community stakeholders with an opportunity to address disagreements surrounding the management of protected areas. Poor conflict resolution mechanisms and lack of opportunities for stakeholder discussion, Hovik et al. (2010, p. 173) argue can lead to 'old hostilities re-igniting and old conflicts becoming more entrenched', which can in turn limit or entirely prevent the delivery of desired governance system outcomes.

Poor connectivity between the stages of the planning and management process was identified as a barrier to governance systems achieving their desired outcomes in 43 papers (18%). Integration issues were observed between various stages of the planning and management process, such as between, implementation and monitoring (Kabote & John, 2017), and monitoring and objective setting (Adams et al., 2017). Jenkins (2018) for example, found that weak connections between the monitoring, and vision and objective setting processes in Wales in the United Kingdom, currently undermines the ability of the governance system to act adaptively and address environmental issues over time. Interestingly, only 21 papers (9%) found weak linkages between research and practice to be a limitation on governance systems delivering their desired outcomes. Weak linkages between research and practice were associated in all of these papers with limitations to governance systems' capacity to develop and implement effective strategies on the ground (B. W. Head et al., 2016; Krause, 2014; Kritsanaphan & Sajor, 2011).

5.1.3. Knowledge

Governance challenges related to the availability and application of different types of knowledge in four broad categories represented 8% of the governance challenges identified across 240 papers. A lack of availability of relevant social, economic, environmental, traditional and historical knowledge was the most commonly identified knowledge related governance challenge and was found in 73 papers (30%). The lack of availability was variously attributed to weak collaborative relationships between institutions and thus limited sharing of knowledge (Temby et al., 2015), incomplete data sets (Anderson et al., 2017; Roncoli et al., 2016; Waylen et al., 2018), and imbalanced focus on collecting scientific rather than social or economic data (B. W. Head et al., 2016).

Difficulties incorporating indigenous knowledge were identified as a governance challenge in only 13 papers (5%). In a 2010 study of traditional knowledge use in water management in Timor Leste, Indigenous knowledge was found to be particularly challenging to integrate into decision-making due to cultural rules around the access and use of such knowledge, and the need to investigate how traditional local knowledge corresponds to scientific understandings of water systems (Palmer, 2010). Clarke et al. (2013, p. 90) suggests that Indigenous and Western knowledge systems can be challenging to integrate because, unlike western knowledge systems, the distribution of indigenous knowledge is often restricted by complex cultural rules and customs regarding different members of society, and their responsibilities in relation to different types of knowledge.

The availability and use of decision-support tools were described as a limiting factor in natural resource management governance in 12 papers (5%). The predominant types of decision-support tools identified included knowledge databases (Klenk et al., 2013; Timberlake & Schultz, 2017), technologies to support 'novel ways of communicating' ecological issues to stakeholder groups (von Heland et al., 2014), and Geographic Information Systems (GIS) and other forms of modelling (Elmqvist et al., 2006; Krause, 2014). In reference to Australian natural resource management organisations, Lockwood et al. (2010) argues that inadequate availability or application of technologies to integrate scientific knowledge into planning and management practices can have significant implications for the number of management actions considered and implemented, increase transaction costs, and reduce the overarching adaptive capacity of the governance system. Only 10 papers (4%) raised retaining knowledge over time as a governance challenge. This suggests that overall knowledge retention is not a significant inhibitor of governance systems capacity to deliver desired outcomes internationally. For example, in a study examining the governance arrangements surrounding the management of land in US national forests, Timberlake and Schultz (2017), found that knowledge retention over time can be limited by the ineffective structural organisation of formal and informal institutions.

6.0 Conclusions

Well-functioning and effective governance systems are increasingly being recognised by theorists and practitioners as critical to the long-term protection and management of natural resources. Consequently, research in the last 15 years has paid particular attention to the constituent elements of 'good', effective, and functional governance systems. Despite these factors, natural resources internationally continue to degrade, and governance systems struggle to address such degradation and broadly maintain or improve the status of interconnected ecological, social, and cultural systems. This study

examined 240 peer-reviewed studies that specifically discussed governance challenges arising in the management of natural resources. The study explored governance challenges broadly as well as the spatial and temporal distribution of studies of governance in natural resource management systems.

This research reveals an increasing emphasis on governance challenges in the literature over a 15-year period, and clear spatial disparities between the number of studies examining natural resource management governance challenges in developed and developing nations. Case studies of governance systems developing nations were more likely to be limited in their decision-making capacity, and lack adequate human and financial resources to support implementation activities, as well as limited leadership on key resource issues, and conflict resolution mechanisms. Alternately, studies of natural resource management governance systems in developed nations were more likely to identify issues surrounding the clarity of policies and the alignment of visions and objectives of stakeholder institutions. This may suggest that governance systems mature at different rates and in different stages, and the elements of a functioning governance system emerge and evolve over time based on the system's maturity. The findings indicate that building capacity, and identifying and accessing different forms of capital are critical in the early stages of governance system development and functionality, which can then be followed by more nuanced stages in which knowledge systems and connectivity between individual institutions can occur and develop, allowing the development of more spatially and temporally strategic and aligned management approaches.

This paper reveals that the capacity of natural resource management governance systems to deliver their desired outcomes internationally is most inhibited by factors that limit connectivity between stakeholders and decision-making, and alignment of vision and objectives across institutions. While natural resource managers face a plethora of governance challenges, it is clear that relationships between stakeholders remain a critical challenge to the broader functionality of governance systems. Most critically, the studies examined in this research emphasise that the strength of these relationships influences institutions capacity to collaborate in the formulation of strategies, access and utilise resources, and align strategic decisions between institutions with varied mandates and capacities. None of the papers in this study suggested that governance challenges were unable to be overcome or would absolutely prevent progress towards desired outcomes in the long-term. Indeed, many of the papers identified a range of success stories in delivering outcomes despite the inhibiting influence of different governance challenges in their specific case studies. Governance systems internationally will continue to face a variety of challenges that influence their capacity to make decisions, however, a greater understanding of these challenges will enable significant opportunities for strategic governance reform, and subsequent improvements in the outcomes being delivered on the ground.

7.0 References

Adams, V. M., Álvarez-Romero, J. G., Capon, S. J., Crowley, G. M., Dale, A., Kennard, M. J., . . . Pressey, R. L. (2017). Making time for space: The critical role of spatial planning in adapting natural resource management to climate change. *Environmental Science and Policy, 74*, 57-67. doi: 10.1016/j.envsci.2017.05.003

Anderson, J. P., Paterson, A. M., Reavie, E. D., Edlund, M. B., & Rühland, K. M. (2017). An introduction to Lake of the Woods—from science to governance in an international waterbody. *Lake and Reservoir Management, 33*(4), 325-334. doi: 10.1080/10402381.2017.1383539

Armitage, D. (2005). Adaptive Capacity and Community-based Natural Resource Management. *Environmental Management, 35*(6), 703-715.

Bell, S., & Park, A. (2006). The Problematic Metagovernance of Networks: Water Reform in New South Wales. *Journal of Public Policy, 26*, 63-83.

Bixler, R. P. (2014). From Community Forest Management to Polycentric Governance: Assessing Evidence from the Bottom Up. *Society & Natural Resources, 27*(2), 155-169. doi: 10.1080/08941920.2013.840021

Bodin, Ö. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science, 357*(6352), eaan1114.

Bouwen, R., & Taillieu, T. (2004). Multi-party Collaboration as Social Learning for Interdependence: Developing Relational Knowing for Sustainable Natural Resource Management. *Journal of Community and Applied Social Psychology, 14*, 137-153.

Brugnach, M., Dewulf, A., Henriksen, H., & van der Keur, P. (2011). More is not always better: coping with ambiguity in natural resources management. *Journal of Environmental Management, 92*, 78-84.

Bullimore, B. (2014). Problems and pressures, management and measures in a site of marine conservation importance: Carmarthen Bay and Estuaries. *Estuarine, Coastal and Shelf Science, 150*, 288-298. doi: https://doi.org/10.1016/j.ecss.2014.05.005

Bushley, B. R. (2010). Seeing the Communities for the Carbon: Governance Challenges of Reducing Emissions from Deforestation and Forest Degradation in Nepal. *Reconsidering Development, 1*(1). doi: -

Cárcamo, P. F., & Gaymer, C. F. (2013). Interactions Between Spatially Explicit Conservation and Management Measures: Implications for the Governance of Marine Protected Areas. *Environmental Management, 52*(6), 1355-1368. doi: 10.1007/s00267-013-0167-9

Cash, D., Adger, N., Berkes, F., Garden, P., Lebel, L., Olsson, P., . . . Young, O. (2006). Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. *Ecology and Society, 11*(2).

Cash, D., & Moser, S. (2000). Linking global and local scales: designing dynamic assessment and management processes. *Global Environmental Change, 10*, 109-120.

Chief, K., Meadow, A., & Whyte, K. (2016). Engaging Southwestern Tribes in Sustainable Water Resources Topics and Management. *Water, 8*(8). doi: 10.3390/w8080350

Clark, S. G., & Vernon, M. E. (2017). Elk management and policy in southern Greater Yellowstone: Assessing the constitutive process. *Policy Sciences, 50*(2), 295-316.

Clarke, B., Stocker, L., Coffey, B., Leith, P., Harvey, N., Baldwin, C., . . . Cannard, T. (2013). Enhancing the knowledge–governance interface: Coasts, climate and collaboration. *Ocean & Coastal Management, 86*, 88-99. doi: https://doi.org/10.1016/j.ocecoaman.2013.02.009

Dale, A., Vella, K., & Potts, R. (2013a). Governance Systems Analysis: A Framework for Reforming Governance Systems. *Journal of Public Administration and Governance, 3*(3), 162-187.

Dale, A., Vella, K., Pressey, R., Brodie, J., Yorkston, H., & Potts, R. (2013b). A method for risk analysis across governance systems: a Great Barrier Reef case study. *Environmental Research Letters, 8*(1), 1-16.

Dale, A., Vella, K., Pressey, R. L., Brodie, J., Gooch, M., Potts, R., & Eberhard, R. (2016). Risk analysis of the governance system affecting outcomes in the Great Barrier Reef. *Journal of Environmental Management, 183, Part 3*, 712-721. doi: https://doi.org/10.1016/j.jenvman.2016.09.013

Daniel, J. R., Pinel, S. L., & Brooks, J. (2013). Overcoming Barriers to Collaborative Transboundary Water Governance. *Mountain Research and Development, 33*(3), 215-224. doi: 10.1659/MRD-JOURNAL-D-12-00121.1

Davidson, J., Lockwood, M., Curtis, A., Stratford, E., & Griffith, R. (2006). Governance Principles for Regional Natural Resource Management *Pathways to good practice in regional NRM governance*: University of Tasmania.

Dietz, T., Rosa, E., & York, R. (2009). Environmentall Efficient Well-Being: Rethinking Sustainability as the Relationship between Human Well-being and Environmental Impacts. *Human Ecology Review, 16*(1), 114-123.

Dunn, G., Harris, L., & Bakker, K. (2015). Microbial risk governance: challenges and opportunities in fresh water management in Canada. *Canadian Water Resources Journal / Revue canadienne des ressources hydriques, 40*(3), 237-249. doi: 10.1080/07011784.2015.1043648

Elmqvist, T., Colding, J., Barthel, S., BorgstrÖM, S., Duit, A., Lundberg, J., . . . Bengtsson, J. (2006). The Dynamics of Social-Ecological Systems in Urban Landscapes: Stockholm and the National Urban Park, Sweden. *Annals of the New York Academy of Sciences, 1023*(1), 308-322. doi: 10.1196/annals.1319.017

Failing, L., Gregory, R., & Harstone, M. (2007). Integrating science and local knowledge in environmental risk management: A decision-focused approach. *Ecological Economics, 64*, 47-60.

Fairhead, J., & Leach, M. (1995). False Forest History, Complicity Social Analysis: Rethinking Some West African Environmental Narratives. *World Development, 23*(6), 1023-1035.

Fidelman, P., Evans, L. S., Fabinyi, M., Foale, S., Cinner, J., & Rosen, F. (2012). Governing large-scale marine commons: Contextual challenges in the Coral Triangle. *Marine Policy, 36*(1), 42-53. doi: https://doi.org/10.1016/j.marpol.2011.03.007

Fleischman, F. D., Boenning, K., Garcia-Lopez, G. A., Mincey, S., Schmitt-Harsh, M., Daedlow, K., . . . Ostrom, E. (2010). Disturbance, Response, and Persistence in

Self-Organized Forested Communities: Analysis of Robustness and Resilience in Five Communities in Southern Indiana. *Ecology and Society, 15*(4).
German, L., Mazengia, W., Taye, H., Tsegaye, M., Ayele, S., Charamila, S., & Wickama, J. (2010). Minimizing the livelihood trade-offs of natural resource management in the Eastern African Highlands: policy implications of a project in "creative governance". *Human ecology, 38*(1), 31-47.
Ghazoul, J., Butler, R., Mateo-Vega, J., & Koh, L. (2010). REDD: A reckoning of environmental and development implications. *Trends in Ecology and Evolution, 25*(7), 396-402.
Head, B. W., Ross, H., & Bellamy, J. (2016). Managing wicked natural resource problems: The collaborative challenge at regional scales in Australia. *Landscape and Urban Planning, 154*, 81-92. doi: https://doi.org/10.1016/j.landurbplan.2016.03.019

Head, L., & Atchison, J. (2015). Governing invasive plants: Policy and practice in managing the Gamba grass (Andropogon gayanus) – Bushfire nexus in northern Australia. *Land Use Policy, 47*, 225-234. doi: https://doi.org/10.1016/j.landusepol.2015.04.009

Hill, M. (2013). Adaptive Capacity of Water Governance: Cases From the Alps and the Andes. *Mountain Research and Development (Online), 33*(3), 248-259.
Holley, C. (2014). Crafting Collaborative Governance: Water Resources, California's Delta Plan, and Audited Self-Management in New Zealand *Environmental Law Reporter, 45*(4).
Hovik, S., Sandström, C., & Zachrisson, A. (2010). Management of protected areas in Norway and Sweden: challenges in combining central governance and local participation. *Journal of Environmental Policy & Planning, 12*(2), 159-177.
Howes, M., Wortley, L., Potts, R., Dedekorkut-Howes, A., Serrao-Neumann, S., Davidson, J., . . . Nunn, P. (2017). Environmental sustainability: A case of policy implementation failure? *Sustainability, 9*(2), 165.
Ison, R. L., Collins, K. B., & Wallis, P. J. (2015). Institutionalising social learning: Towards systemic and adaptive governance. *Environmental Science & Policy, 53*, 105-117.

Jenkins, V. (2018). Sustainable Management of Natural Resources: Lessons from Wales. *Journal of Environmental Law*.
Juerges, N., & Hansjürgens, B. (2018). Soil governance in the transition towards a sustainable bioeconomy–A review. *Journal of Cleaner Production, 170*, 1628-1639.
Kabote, S. J., & John, P. (2017). Water Governance in Tanzania: Performance of Governance Structures and Institutions. *World Journal of Social Sciences and Humanities, 3*(1), 15-25. doi: 10.12691/wjssh-3-1-3

Kemp, R., & Parto, S. (2005). Governance for sustainable development: moving from theory to practice. *Internatinal Journal of Sustainable Development, 8*(1), 12-30

Klenk, N. L., Reed, M. G., Lidestav, G., & Carlsson, J. (2013). Models of Representation and Participation in Model Forests: Dilemmas and Implications for Networked Forms of Environmental Governance Involving Indigenous People. [Article]. *Environmental Policy & Governance, 23*(3), 161-176. doi: 10.1002/eet.1611

Korhonen-Kurki, K., Brockhaus, M., Bushley, B. R., Babon, A., Gebara, M. F., Kengoum, F., . . . Maharani, C. (2016). Coordination and cross-sectoral integration in REDD+: experiences from seven countries. *Climate and Development, 8*(5), 458-471. doi: 10.1080/17565529.2015.1050979

Krause, G. (2014). The scientific challenge of bridging the gap from the local to the earth system level: lessons from the study of mangroves and people in North Brazil. *Regional environmental change, 14*(6), 2089-2103.

Kritsanaphan, A., & Sajor, E. (2011). Intermediaries and informal interactions in decentralised environmental management in peri-urban Bangkok. *International Development Planning Review, 33*(3), 247-272.

Kuzdas, C., Wiek, A., Warner, B., Vignola, R., & Morataya, R. (2015). *Integrated and Participatory Analysis of Water Governance Regimes: The Case of the Costa Rican Dry Tropics* (Vol. 66).

Lockwood, M., Davidson, J., Curtis, A., Stratford, E., & Griffith, R. (2010). Governance Principles for Natural Resource Management. *Society and Natural Resources, 23*, 986-1001.

Marcus, R. R., & Onjala, J. (2008). Exit the State: Decentralization and the Need for Local Social, Political, and Economic Considerations in Water Resource Allocation in Madagascar and Kenya. *Journal of Human Development, 9*(1), 23-45. doi: 10.1080/14649880701811385

McConnell William, J., & Sweeney Sean, P. (2005). Challenges of forest governance in Madagascar. *The Geographical Journal, 171*(3), 223-238. doi: 10.1111/j.1475-4959.2005.00162.x

McFadgen, B., & Huitema, D. (2017). Are all experiments created equal? A framework for analysis of the learning potential of policy experiments in environmental governance. *Journal of Environmental Planning and Management, 60*(10), 1765-1784.

Mitchell, M., Griffith, R., Ryan, P., Walkerden, G., Walker, B., Brown, V. A., & Robinson, S. (2014). Applying Resilience Thinking to Natural Resource Management through a "Planning-By-Doing" Framework. *Society & Natural Resources, 27*(3), 299-314. doi: 10.1080/08941920.2013.861556

Moed, H. F., Bar-Ilan, J., & Halevi, G. (2016). A new methodology for comparing Google Scholar and Scopus. *Journal of informetrics, 10*(2), 533-551.

Morrison, T. (2007). Multiscalar Governance and Regional Environmental Management in Australia. *Space and Polity, 11*(3), 227-241.

Morrison, T. H. (2007). Multiscalar Governance and Regional Environmental Management in Australia. *Space and Polity, 11*(3), 227-241. doi: 10.1080/13562570701811551

Mulrow, C. D. (1994). Systematic reviews: rationale for systematic reviews. *BMJ, 309*(6954), 597-599.

Mycoo, M. A., Griffith-Charles, C., & Lalloo, S. (2017). Land management and environmental change in small-island-developing states: the case of St. Lucia. *Regional environmental change, 17*(4), 1065-1076.

Njaya, F. (2007). Governance Challenges of the Implementation of Fisheries Co-Management : Experiences from Malawi. *International Journal of the Commons, 1*(1), 137-153.
O'Neill, K. (2017). *The environment and international relations*: Cambridge University Press.

Ostrom, E. (2012). Nested externalities and polycentric institutions: must we wait for global solutions to climate change before taking actions at other scales? *Economic Theory, 49*, 353-369.
Palmer, L. (2010). Enlivening development: Water management in post-conflict Baucau city, Timor-Leste. *Singapore Journal of Tropical Geography, 31*(3), 357-370. doi: 10.1111/j.1467-9493.2010.00404.x

Petursson, J., & Vedeld, P. (2017). *Rhetoric and reality in protected area governance: Institutional change under different conservation discourses in Mount Elgon National Park, Uganda* (Vol. 131).

Price, K., Roburn, A., & Mackinnon, A. (2009). *Ecosystem-based management in the Great Bear Rainforest* (Vol. 258).

Pullin, A. S., & Stewart, G. B. (2006). Guidelines for systematic review in conservation and environmental management. *Conservation biology, 20*(6), 1647-1656.
Rapport, D., Constanza, R., & McMichael, A. (1998). Assessing ecosystem health. *Trends in Ecology and Evolution, 13*(10), 397-402.
Raymond, C., Fazey, I., Reed, M., Stringer, L., Robinson, G., & Evely, A. (2010). Integrating local and scientific knowledge for environmental management. *Journal of Environmental Management, 91*, 1766-1777.
Razzaque, J. (2017). Payments for ecosystem services in sustainable mangrove forest management in Bangladesh. *Transnational Environmental Law, 6*(2), 309-333.

Riggs, R. A., Langston, J. D., Margules, C., Boedhihartono, A. K., Lim, H. S., Sari, D. A., . . . Sayer, J. (2018). Governance Challenges in an Eastern Indonesian Forest Landscape. *Sustainability, 10*(1), 169.
Robins, L. (2008). Perspectives on capacity building to guide policy and program development and delivery. *Environmental Science & Policy, 11*(8), 687-701. doi: https://doi.org/10.1016/j.envsci.2008.07.003

Roncoli, C., Dowd-Uribe, B., Orlove, B., West Colin, T., & Sanon, M. (2016). Who counts, what counts: representation and accountability in water governance in the Upper Comoé sub-basin, Burkina Faso. *Natural Resources Forum, 40*(1-2), 6-20. doi: 10.1111/1477-8947.12095

Schafer, J. G. (2016). Mandates to Coordinate: The Case of the Southern Nevada Public Lands Management Act. *Public Performance & Management Review, 40*(1), 23-47.

Scheba, A. (2017). *Conservation agriculture and sustainable development in A frica: i nsights from T anzania.* Paper presented at the Natural Resources Forum.

Simms, R., Harris, L., Joe, N., & Bakker, K. (2016). Navigating the tensions in collaborative watershed governance: Water governance and Indigenous communities in British Columbia, Canada. *Geoforum, 73*, 6-16.

Smith, K., & Lawrence, G. (2018). From disaster management to adaptive governance? Governance challenges to achieving resilient food systems in Australia. *Journal of Environmental Policy & Planning, 20*(3), 387-401.

Sreeja, K. G., Madhusoodhanan, C. G., Shetty, P. K., & Eldho, T. I. (2012). Inclusive spaces in integrated river basin management: discerning multiple boundaries of resource relations. *International journal of river basin management, 10*(4), 351-367.

Tamazian, A., Chousa, J., & Vadlamannati, K. (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy, 37*(1), 246-253.

Temby, O., Rastogi, A., Sandall, J., Cooksey, R., & Hickey, G. M. (2015). Interagency trust and communication in the transboundary governance of Pacific salmon fisheries. *Review of Policy Research, 32*(1), 79-99.

Timberlake, T. J., & Schultz, C. A. (2017). Policy, practice, and partnerships for climate change adaptation on US national forests. *Climatic Change, 144*(2), 257-269.

Vink, M. J., Dewulf, A., & Termeer, C. (2013). The role of knowledge and power in climate change adaptation governance: a systematic literature review. *Ecology and Society, 18*(4).

von Heland, F., Clifton, J., & Olsson, P. (2014). Improving stewardship of marine resources: linking strategy to opportunity. *Sustainability, 6*(7), 4470-4496.

Waylen, K. A., Holstead, K. L., Colley, K., & Hopkins, J. (2018). Challenges to enabling and implementing Natural Flood Management in Scotland. *Journal of Flood Risk Management, 11*, S1078-S1089.

Yeboah-Assiamah, E., Muller, K., & Domfeh, K. A. (2017). Institutional assessment in natural resource governance: A conceptual overview. *Forest policy and economics, 74*, 1-12.

Young, O. (1997). Rights, Rules, and Resources in World Affairs. In O. Young (Ed.), *Global Governance: Drawing Insights from the Environmental Experience*. Cambridge: MIT Press.